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REPUBLIC OF SOUTH AFRICA

EPARTEMENT VAN HANDEL
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Certificate

PATENT OFFICE
REPUBLIEK VAN SUID-AFRIKA

08.12.03

DEPARTMENT OF TRADE AND INDUSTRY

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the documents attached hereto are true copies of the Forms P2, P6, provisional specification and drawings of South African Patent Application No. 2002/8777 in the name of Element Six (Proprietary) Limited

PRIORITY DOCUMENT
SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

Filed : 30 October 2002

Entitled : Tool insert

teken te / ned at PRETORIA in die Republiek van Suid-Afrika, hierdie / in the Republic of South Africa, this **20th** dag van / day of **October 2003**

Registrateur van Patente

SPOOR & FISHER

FORM P.1

REVENUE

REPUBLIC OF SOUTH AFRICA
PATENTS ACT, 1978

APPLICATION FOR A PATENT

AND ACKNOWLEDGEMENT OF RECEIPT
(Section 30 (1) – Regulation 22)

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HASR 711
INKOMSTE

The granting of a patent is hereby requested by the undermentioned applicant on the basis of the present application filed in duplicate

OFFICIAL APPLICATION NO.

21	01	2002/8777

S & F REFERENCE

PA133634/P

FULL NAME(S) OF APPLICANT(S)

71	ELEMENT SIX (PROPRIETARY) LIMITED

ADDRESS(ES) OF APPLICANT(S)

	DEBID ROAD, NUFFIELD, SPRINGS, 1559, GAUTENG, SOUTH AFRICA

TITLE OF INVENTION

54	TOOL INSERT

THE APPLICANT CLAIMS PRIORITY AS SET OUT ON THE ACCOMPANYING FORM P.2. THE EARLIEST PRIORITY CLAIM IS:

COUNTRY: NIL NUMBER: NIL DATE: NIL

~~THIS APPLICATION IS FOR A PATENT OF ADDITION TO PATENT APPLICATION NO.~~

21	01	

~~THIS APPLICATION IS A FRESH APPLICATION IN TERMS OF SECTION 37 AND IS BASED ON APPLICATION NO.~~

21	01	

THIS APPLICATION IS ACCOMPANIED BY:

- ☒ 1. A single copy of a provisional specification of 10 pages.
- ☒ 2. Drawings of 2 sheets.
- ☐ 3. Publication particulars and abstract (Form P.8 in duplicate).
- ☐ 4. A copy of Figure of the drawings (if any) for the abstract.
- ☐ 5. Assignment of invention.
- ☐ 6. Certified priority document.
- ☐ 7. Translation of the priority document.
- ☐ 8. Assignment of priority rights.
- ☐ 9. A copy of the Form P.2 and the specification of S.A. Patent Application No .
- ☐ 10. Declaration and power of attorney on Form P.3.
- ☐ 11. Request for ante-dating on Form P.4.
- ☐ 12. Request for classification on Form P.9.
- ☒ 13. Form P.2 in duplicate.
- ☐ 14. Other.

74	ADDRESS FOR SERVICE: SPOOR & FISHER, SANDTON

Dated: 30 October 2002

SPOOR & FISHER
PATENT ATTORNEYS FOR THE APPLICANT(S)

RECEIVED

REGISTRAR OF PATENTS DESIGNS, TRADE MARKS AND COPYRIGHT
2002 -10- 30
REGISTRATEUR VAN PATENTE, MODELLE, HANDELSMERKE EN OUTEURSREG

REGISTRAR OF PATENTS

FORM P.2

REPUBLIC OF SOUTH AFRICA	REGISTER OF PATENTS	PATENTS ACT, 1978

OFFICIAL APPLICATION		LODGING DATE: PROVISIONAL		ACCEPTANCE DATE	
21	01 2002/8777	22	30 OCT 2002	47	
INTERNATIONAL CLASSIFICATION		LODGING DATE: COMPLETE		GRANTED DATE	
51		23			

FULL NAME(S) OF APPLICANT(S)/PATENTEE(S)

71 ELEMENT SIX (PROPRIETARY) LIMITED

APPLICANTS SUBSTITUTED:		DATE REGISTERED
71		

ASSIGNEE(S)		DATE REGISTERED
71		

FULL NAME(S) OF INVENTOR(S)

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3. CHAPMAN, RAYMOND ALBERT

PRIORITY CLAIMED	COUNTRY		NUMBER		DATE	
N.B. Use International abbreviation for country (see Schedule 4)	33	NIL	31	NIL	32	NIL

TITLE OF INVENTION

54 TOOL INSERT

ADDRESS OF APPLICANT(S)/PATENTEE(S)

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ADDRESS FOR SERVICE		S & F REF
74	SPOOR & FISHER, SANDTON	PA133634/P

PATENT OF ADDITION NO.		DATE OF ANY CHANGE
61		
FRESH APPLICATION BASED ON		DATE OF ANY CHANGE

SPOOR & FISHER

FORM P.6

REPUBLIC OF SOUTH AFRICA
PATENTS ACT, 1978

PROVISIONAL SPECIFICATION

(Section 30(1) – Regulation 27)

OFFICIAL APPLICATION NO.		
21	01	2002/8777

LODGING DATE	
22	30 OCTOBER 2002

FULL NAMES OF APPLICANTS

71	ELEMENT SIX (PROPRIETARY) LIMITED

FULL NAMES OF INVENTORS

72	TANK, KLAUS ACHILLES, ROY DERRICK CHAPMAN, RAYMOND ALBERT

TITLE OF INVENTION

54	TOOL INSERT

BACKGROUND OF THE INVENTION

THIS invention relates to tool inserts and more particularly tool inserts which can be used as cutting elements in rotary drilling bits intended for subterranean rock drilling.

The use of diamond compacts, also known as PCD, as cutters in drilling operations is well known due to the high abrasion resistant properties of diamond cutters. It is also well established that diamond cutters cannot be used satisfactorily for milling or drilling through ferrous substrates such as steel. Therein lies a problem in the use of diamond cutters in certain down the hole drilling operations, particularly with regard to subterranean directional drilling, such as drilling horizontally into a rockbed from an underground location in a vertical borehole or shaft.

In order to drill horizontally into a rockbed from an underground location, it is necessary to change the direction of movement of the drill bit from a vertical direction to a horizontal direction. To do so, a steel casing is typically positioned down the vertical borehole or shaft, creating a lining therefor in the region requiring horizontal drilling. Located within the steel casing is a deflector which is positioned adjacent the position where horizontal drilling is to be carried out. The function of the deflector, which is generally wedge-shaped, is to cause the drill to change direction and begin milling through the steel casing to create a window to the bedrock.

As PCD is not suitable for drilling through the steel casing due to reactions with the ferrous materials, an alternative drill bit insert is required. Accordingly, tungsten carbide cutters are typically used in the drill bit to mill through the steel casing. Once through the casing, the tungsten carbide inserts have to be replaced with abrasive resistant cutters such as diamond

cutters in order to drill into the bedrock. This means that the drill bit has to be removed and replaced with an appropriate bit. As the drill strings that have to be removed are very long, this is a time consuming exercise that results in costly downtime.

SUMMARY OF THE INVENTION

According to one aspect of the invention, a tool insert comprises:

a substrate;

a layer of ultra-hard abrasive material bonded to the substrate, the layer of ultra-hard abrasive material having a side surface and a top surface, a portion of the periphery of the top surface of the ultra-hard abrasive material providing a primary cutting edge for the tool insert; and

a protective layer, a surface of the protective layer being bonded to the top surface and/or the side surface of the ultra-hard abrasive material so as to protect the primary cutting edge of the ultra-hard abrasive material, a periphery of the protective layer providing a secondary cutting edge for the tool insert, the depth of the protective layer being selected so as to be sufficient to protect the primary cutting edge whilst milling a window through a casing or lining of a borehole or shaft but to expose the primary cutting edge soon after encountering a rockbed to be drilled.

According to a further aspect of the invention, a method of drilling a horizontal or angled hole in a subterranean rock formation includes the steps of:

1) preparing the site for horizontal or angled drilling by a) using an existing borehole or, if not available, drilling a borehole

into a subterranean rock formation to an appropriate depth and b) lining the borehole, at least in the region where horizontal or angled drilling is to take place, with a casing having a passage and a deflector means mounted in the passage;

2) providing a drill bit with at least one cutting tool insert, the or each cutting tool insert comprising a substrate, a layer of ultra-hard abrasive material bonded to the substrate, the ultra-hard abrasive material providing a primary cutting edge for the tool insert, and a protective layer for protecting the primary cutting edge and for providing a secondary cutting edge;

3) guiding the drill bit down the borehole until it contacts the deflector and is deflected towards the casing;

4) milling a window through the casing or lining to the subterranean rock formation; and

5) drilling a hole in the subterranean rock formation,

wherein the depth of the protective layer is sufficient to protect the primary cutting edge whilst milling through the casing or lining and to expose the primary cutting edge soon after encountering the subterranean rock formation.

The above method can also be used for the drilling of multiple directional holes from the central vertical borehole.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described in more detail, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a schematic sectional side view of a rotary drill bit in a subterranean rock drilling operation;

Figure 2 is a sectional side view of a first embodiment of a tool insert of the invention;

Figure 3 is a plan view of the tool insert of figure 2;

Figure 4 is a sectional side view of a second embodiment of a tool insert of the invention;

Figure 5 is a sectional side view of a third embodiment of a tool insert of the invention;

Figure 6 is a plan view of the tool insert of Figure 5;

Figure 7 is a sectional side view of a fourth embodiment of a tool insert of the invention;

Figure 8 is a plan view of the tool insert of Figure 7;

Figure 9 is a sectional side view of a fifth embodiment of a tool insert of the invention;

Figure 10 is a plan view of the tool insert of Figure 9;

Figure 11 is a sectional side view of a sixth embodiment of a tool insert of the invention; and

Figure 12 is a plan view of the tool insert of Figure 11.

DESCRIPTION OF EMBODIMENTS

Referring to figure 1 a drill assembly 10 consists of a rotary drill string 12 and a rotary drill bit 14, of the drag bit kind in this case.

The drill bit 14 is directed down a passage 16 within a steel tubular casing 18. The steel casing 18 is anchored in a borehole or shaft 20 drilled into a subterranean bedrock 22.

In order for the rotary drill bit 14 to drill a horizontal or angled hole in the bedrock 22 in the region indicated by an 'X', it is necessary for the drill bit 14 to be redirected from a vertical direction of movement to a horizontal or angled direction of movement, along the arrow 24. A deflector 26, which is attached to the casing 18 and which has previously been positioned adjacent the region 'X', causes the bit 14 to change direction in this manner. The deflector 26 is supported by an anchor 28.

As mentioned previously, in order to drill through the casing 18, typically cemented tungsten carbide cutters have traditionally been used. Once a window 30 has been milled through the casing 18, the drill bit 14 is withdrawn and replaced with a drill bit having abrasion resistant cutters such as PCD cutters. This time consuming operation is obviated by using tool inserts or cutters of the invention.

The layer of ultra-hard abrasive material will generally be a layer of PCD, although under appropriate conditions PCBN may also be used. The layer may also be a layer of diamond produced by chemical vapour deposition, called CVD diamond.

The substrate will generally be a cemented carbide substrate. Such substrates are well known in the art and are generally cemented tungsten carbide substrates.

The protective layer, which may be an extension of the substrate or a separate layer, will also generally be of cemented tungsten carbide, although it may be of a different grade to that of the substrate. In certain instances, the protective layer may be formed of tool steel or other appropriate material suited to milling through steel or other material used for the casing or lining.

Referring to figures 2 and 3, a first embodiment of a tool insert of the invention is illustrated. A cemented carbide substrate 40 has a planar base surface 42 and an upper surface 44. A centrally located recess 46 is formed in the upper surface 44. The recess 46 is surrounded by an annular region 48 and has a surface 50. Although the recess 46 is centrally located in this embodiment, it could also be positioned off centre.

The recess 46 is filled with diamond particles. Thereafter, the diamond-filled substrate 40 is placed in a reaction capsule and the reaction capsule placed in the reaction zone of a conventional high pressure/high temperature apparatus. The capsule is exposed to conditions of high pressure and temperature suitable to produce a diamond abrasive compact (PCD) 52. Under these conditions the PCD 52 will form and bond to the cemented carbide substrate over the entire surface which defines the recess 46. A cutting edge 54, the primary cutting edge of the tool insert, is defined by the periphery of the PCD 52.

The cemented carbide / PCD body is then removed from the reaction capsule using known techniques. As such the cemented carbide / PCD body forms a precursor of a tool insert of the invention.

To produce a tool insert of the invention, the annular region 48 of the substrate 40 is ground or otherwise removed so as to leave a

predetermined depth, indicated by the numeral 56, of tungsten carbide material. This depth of material 56 is selected so as to correspond to the amount of tungsten carbide material required to mill through the wall of a steel casing or lining of a borehole, as described above. To this end, the depth of tungsten carbide 56 provides a protective layer for the primary cutting edge 54 of the PCD 52, and also a secondary cutting edge 58 for milling through the steel casing. Once a window has been milled through the steel casing, ideally the layer 56 should be almost expended so as to expose the cutting edge 54 for drilling into the rockbed.

In some applications, the tungsten carbide substrate 40, whilst having the desired properties for forming the PCD layer 52, may not have the desired properties for milling through a steel casing or lining. In view thereof, the annular protective layer 48 may be replaced by tungsten carbide of a different grade or by another suitable material, such as tool steel, for example. The annular region 48 in such a case could be formed as a ring in situ or, alternatively, could be formed as a separate ring component which is attached to the tool insert. The ring 48 may be attached to the tool insert, which has been machined to accept the ring, by for example brazing, press fitting, shrink fitting or any other convenient method.

As the function of the protective layer is to protect the cutting edge of the PCD and provide a cutting edge for drilling through a steel substrate, it need not be an extension of the substrate of the tool insert as described above. As shown in figure 4, a second embodiment of a tool insert of the invention comprises a tungsten carbide substrate 60, a PCD layer 62 having a cutting edge 64, and a tungsten carbide protective layer 66 having a cutting edge 68. As before, the depth 70 of the protective layer 66 is selected so as to mill a window through the steel casing or lining of a borehole in a subterranean bedrock whilst exposing the PCD cutting edge 64 once through the steel casing.

A third embodiment of a tool insert of the invention is illustrated in figures 5 and 6 of the accompanying drawings. The tool insert consist of a cemented

carbide substrate 80, a PCD layer 82, having a cutting edge 84, and a tungsten carbide protective segment 86, having a cutting edge 88, bonded to the substrate 80. The tungsten carbide segment 86 could be an extension of the substrate 80. Alternatively, if the grade of the tungsten carbide substrate 80 is not appropriate for the cutting of a particular grade of steel, the tungsten carbide segment 86 could be formed of a tungsten carbide material of a different grade that is adapted to the particular substrate to be milled. The depth of the tungsten carbide segment 86 is once again selected so as to protect the cutting edge 84 whilst drilling through a steel casing, but to expose the cutting edge 84 soon after encountering the subterranean bedrock.

Referring to figures 7 and 8, which illustrate a fourth embodiment of a tool insert of the invention, a tungsten carbide substrate 90 includes a number of parallel recesses 92 in which parallel PCD segments 94 are formed. The PCD segments 94 are protected by respective tungsten carbide segments 96. In this arrangement, the cutting edges 98 of respective PCD segments 94 are protected by the tungsten carbide segments 96, which in turn have cutting edges 100. This arrangement allows the tool insert to be used for cutting through successive layers of steel and subterranean bedrock and can therefore be used multiple times.

Turning to figures 9 and 10, a fifth embodiment of a tool insert of the invention is shown. The tool insert comprises a tungsten carbide substrate 110, a PCD layer 112 located within a recess 114 and surrounded by an annular section 116 of the tungsten carbide substrate, and a protective layer or ring 118 surrounding the ring 116. The ring 118 may be formed of a different grade of tungsten carbide or, alternatively, formed of tool steel or other appropriate material for cutting through the steel casing or lining of a borehole in a subterranean bedrock. The ring 118 includes a cutting edge 120 for cutting through the steel casing or lining. In this arrangement, the tungsten carbide of the substrate 110 and ring 116 is selected for its properties in forming the PCD layer whilst the ring 118 is selected so as to optimize the milling through the steel casing or lining. Whilst the annular

ring 116 of tungsten carbide acts as a further protective layer for the cutting edge 122 of the PCD layer 112, its primary purpose is to optimize the formation of the PCD layer in a conventional high pressure/high temperature process. The ring 118 may be formed in situ or, alternatively, may be formed as a separate component which is brazed onto or otherwise attached to the substrate 110.

Referring to figures 11 and 12, a sixth embodiment of a tool insert of the invention comprises a substrate 130 on which is formed a PCD layer 132. Typically, the substrate 130 and PCD layer 132 would be formed in a conventional high pressure/high temperature apparatus, whereafter the relevant portion of the substrate would be ground away to expose the primary cutting edge 134 of the PCD layer 132. In order to protect the cutting edge 134 in a subterranean rock drilling process of the invention, the substrate 130 and PCD layer 132 are brazed into a cup 136 which is typically formed of a high speed tool steel, which cup 136 includes a cutting edge 138 for milling through the steel casing or lining of a borehole in a subterranean rockbed.

As should be evident from the above, a number of different configurations of the tool insert of the invention are possible in order to achieve the desired purpose of protecting the primary cutting edge of a PCD layer whilst milling a window through the steel casing or lining of a borehole in a subterranean bedrock, and exposing the PCD cutting edge once through the steel casing.

DATED THIS 30th DAY OF OCTOBER 2002

SPOOR & FISHER
APPLICANT'S PATENT ATTORNEYS